

Results from Our Recently Delivered Automated Reflectometer for Measurement of Reflectivity of EUV Lithography Masks

Rupert C. C. Perera & James H. Underwood

EUV Technology, Martinez, CA 94553 / www.EUVL.com / E-mail: RCPerera@EUVL.com



1. Abstract

Based on a laser plasma source, EUV Technology has delivered a recipe driven automated Reflectometer for the measurement of reflectivity and uniformity of multilayer coatings for EUV lithography mask blanks, without removal from the clean environment. An in-vacuum transfer system allows the mask blank to be transferred from a RSP 200 to the measurement chamber with minimum added particles. By translating the mask blank using a high precision, clean x-y stage, measurements can be made at any point on its surface. A multilayer reflectivity curve is obtained in about 20 seconds and about 8,000 reflectivity measurements can be obtained without changing the target. The instrument achieves a peak reflectivity precision, 1σ of 0.1%, and a centroid wavelength precision of 1σ of 0.0005 nm, figures which compare very favorably with results obtained at synchrotron radiation facilities. This instrument is commercially available and has been delivered to several customers.

2. Need for a Compact, Dedicated EUV Reflectometer

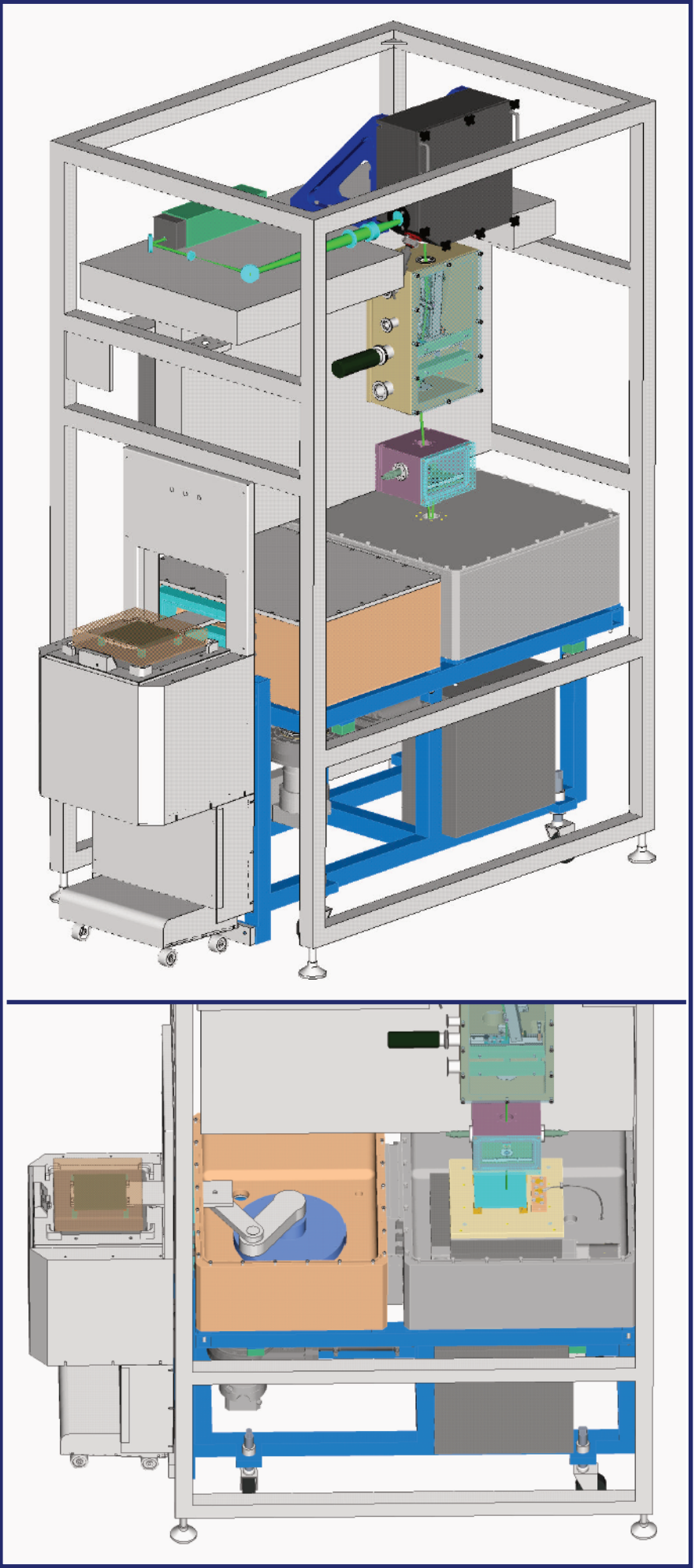
EUV mask makers will require a tool for quality control of the mask blanks for next-generation EUV Lithography which employs very short wavelength light (13.4 nm) to provide the optical resolution needed for advanced semiconductor device scaling. The mask blanks are made by coating 6" square extremely smooth glass substrates with molybdenum-silicon multilayer Bragg reflectors deposited by ion-beam sputtering. It is very important that these coatings be deposited with high uniformity over the entire wafer to provide a flat surface of uniform and maximum reflectivity at the exposure wavelength. Furthermore, the masks must be free from particulate contamination. Rejection of mask blanks because of low reflectivity or poor uniformity will lead to an unacceptably low yield.

Prior to the development of this EUV Reflectometer, the reflectivity and centroid wavelength of the masks were measured by transporting them to a synchrotron radiation facility equipped to make such measurements, a procedure which is inefficient and time consuming. Also, due to particle contamination, the mask blanks must be re-cleaned prior to using them which significantly increases the possibility of damaging the mask due to excessive handling.

3. Specifications of Stand-alone Reflectometer with a Clean Vacuum Robotic Sample Transfer System for the Metrology of EUV Mask Blank Coatings using a Laser Plasma Source

Specifications of the EUV Reflectometer Model No. LPR1016-FS1515:

- Wavelength precision (1σ): 0.001 nm (0.008%).
- Reflectivity precision (1σ): 0.3% absolute.
- Can obtain a complete reflectivity curve in less than 30 seconds.
- Wavelength range: 10 to 16 nm.
- 250,000 shots per target change (about 8000 reflectivity curves without changing the laser target).
- Measurement area: 152 mm x 152 mm mask blanks with positioning accuracy of 0.1 mm.
- Substrate thickness: up to 6.25 mm.
- Designed to measure reflectivity at 84° angle.
- Class 1 cleanroom compatible.
- Measurement spot size: about 1 mm x 2 mm.
- Footprint of the instrument less than 2.0 m by 2.0 m.
- User friendly LabView based software to control the instrument and to analyze the reflectivity measurements.
- Extremely reliable vacuum mask blank handling robot to transfer the mask blanks from a standard container (RSP200).
- Recipe handling, manual parameter setup from GUI and remote accessible.
- SEMI S2/S8 certified.
- SEMI F47 certified.
- SECS option for Fab integration.

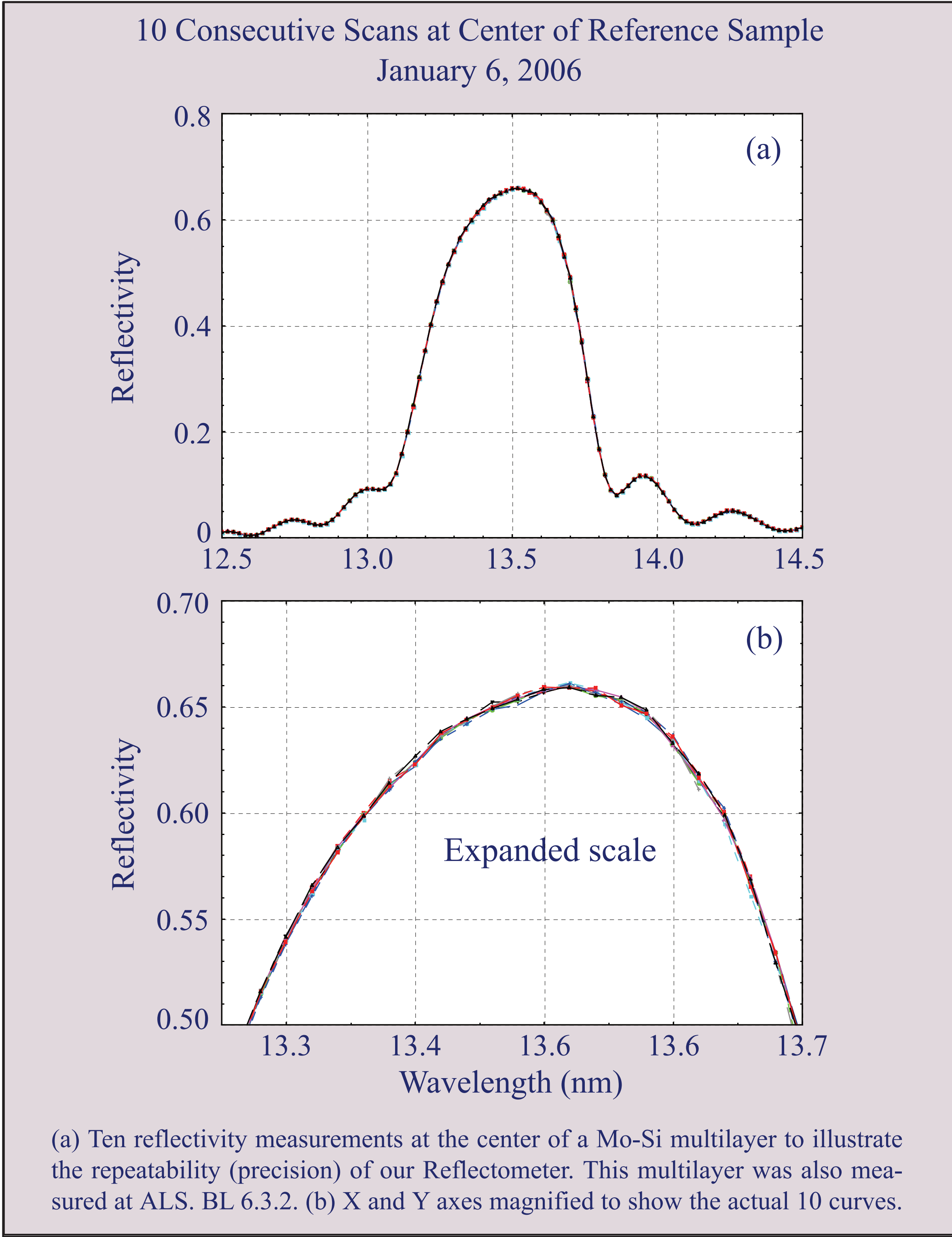


Front view of the Reflectometer.

Back view of the Reflectometer

Inside of the Reflectometer.

4. Measurements on a Reference Sample with the EUV Technology Reflectometer



Comparisons with measurements from ALS are as follows:

	EUV Technology	ALS	Accuracy
Reflectivity	65.90%	65.93%	0.03% (Abs.)
Centroid wavelength	13.471 nm	13.470 nm	0.001 nm
FWHM	0.560 nm	0.561 nm	0.001 nm

The measured precisions (1σ) are as follows:

Reflectivity:	0.064 % (absolute)
Centroid wavelength:	0.0004 nm
FWHM:	0.0005 nm

Measurements on a EUV reticle: Average of 8 measurements for 5 locations on the same reticle, load and unload the reticle between each measurement. February 13, 2006.

X (mm)	Y (mm)	Rmax % (abs)	Rmax % 3σ	FWHM (nm)	FWHM 3σ (nm)	Centroid (nm)	Centroid 3σ (nm)
0	0	63.93	0.652	0.544	0.0023	13.470	0.0009
60	60	63.63	0.498	0.548	0.0030	13.510	0.0008
-60	60	63.75	0.484	0.548	0.0019	13.506	0.0009
-60	-60	63.69	0.657	0.548	0.0026	13.498	0.0010
60	-60	63.53	0.565	0.548	0.0023	13.500	0.0011

5. New Products

1. Combined Resist Exposure and Reflectivity Measurement Tool EUV Technology Model No. EUV-RER1314: Designed for screening candidate EUV resist formulations for possible use in other EUV tools by measuring the relative decrease in integrated reflected EUV power from a witness ML witness mirror and using a high sensitive UHV RGA detection system.

2. Reflectometer for Patterned masks, EUV Technology Model No. EUV-RPM1314: Designed for measurement of the EUV reflectivity of patterned masks with high throughput, small measurement spot and high repeatability for EUV lithography.

6. Conclusion

In addition to being the first commercially available EUV Reflectometer to obtain reflectivity data of quality equal to that obtained at synchrotron radiation facilities, it is the first stand-alone Reflectometer that can be operated in a clean room environment on the floor of the mask shop. Hence we consider it a giant step in the migration of the technology of EUV lithography from the national laboratories to commercial manufacturing facilities.

7. Purchasing Information

Since EUV Technology's inception in 1997, we have been actively involved in the manufacturing of R&D tools for EUV Lithography and have provided many of the frontrunners in the semiconductor industry with EUV calibration tools. Our recent customers include Lawrence Livermore Laboratory, International SEMATECH, and major semiconductor manufacturers in California's Silicon Valley and Asia.



In 2005, EUV Technology's LPR1016 Reflectometer was awarded R&D Magazine's "R&D 100 Award" and heralded by the magazine's editors as "one of the 100 most technologically significant products introduced into the marketplace over the past year." Currently, EUV Technology's LPR1016 Reflectometer is manufactured under patent number US 6,738,135 B1.

Purchase inquiries can be made by contacting:

www.EUVL.com

Sales Department

EUV Technology

837 Arnold Drive, Suite 400
Martinez, CA 94553

Phone: 1-925-229-4388

FAX: 1-925-229-4387

E-mail: sales@euvl.com

